

Table 4.4 – Recommended Minimum Moments of Inertia for Selecting Reinforcing Members for Steel Filter Housings under Negative Pressure^{a, b}

Reinforcement		Moment of inertia (in. ⁴) ^d for negative pressure (relative to outside)					
Length ^c (in.)	Spacing (in.)	4 in.wg	8 in.wg	12 in.wg	20 in.wg	1 psi	2 psi
54 (2)	12	0.04	0.04	0.04	0.04	0.04	0.08
	24	0.04	0.04	0.04	0.06	0.08	0.16
	36	0.04	0.04	0.05	0.09	0.12	0.24
	48	0.04	0.05	0.07	0.12	0.16	0.32
80 (3)	12	0.04	0.04	0.05	0.08	0.11	0.21
	24	0.04	0.06	0.09	0.16	0.21	0.43
	36	0.05	0.10	0.14	0.24	0.32	0.63
	48	0.06	0.13	0.19	0.32	0.42	0.86
106 (4)	12	0.04	0.09	0.13	0.22	0.30	0.60
	24	0.09	0.18	0.26	0.44	0.60	1.19
	36	0.13	0.27	0.39	0.66	0.90	1.79
	48	0.18	0.36	0.52	0.88	1.19	2.38
132 (5)	12	0.09	0.17	0.26	0.51	0.69	1.39
	24	0.18	0.34	0.52	1.02	1.39	2.78
	36	0.27	0.51	0.78	1.53	2.08	4.17
	48	0.36	0.68	1.04	2.04	2.76	5.55
158 (6)	12	0.15	0.29	0.44	0.73	1.0	2.0
	24	0.29	0.59	0.88	1.46	2.0	4.0
	36	0.44	0.87	1.32	2.19	3.0	6.0
	48	0.58	1.16	1.76	2.19	4.0	8.0

^aBased on permissible deflection of 1/8 in./ft.

^bUniformly loaded beam, 50 percent simply supported and 50 percent fixed end assumed.

^cLength based on 2-in. spacing between 24- by 24-in. filter units; the numbers within parentheses denote number of filter units. The metal thicknesses are adequate for panel lengths within ±10 in. of the length shown.

^dStructural angles can be chosen from the tables given in the AISC *Manual of Steel Construction*.⁹

Note: This table is intended to provide information only. The designer is responsible for verifying this information.

Housings installed inside a reactor containment may experience a pressure lag during rapid pressurization of the containment following a major accident. Unless the housings are equipped with pressure-relief dampers, this lag could result in a pressure differential between the housing and containment substantial enough to collapse the housing.

Reinforcing members should be spaced to minimize vibration and audible drumming of the housing walls, which can be transmitted through the system. Reinforcements should be installed on the outside of the housing, when possible, to eliminate interior ledges and projections that collect dust and constitute hazards to personnel working in the housing (**FIGURE 4.38**). All sharp corners, welds, weld spatter, and projections inside the housing should be ground smooth. The housing design must minimize cracks and crevices that are difficult to clean and that may collect moisture that can cause corrosion.

Mastics and caulking compounds, including silicone-based, room-temperature vulcanizing (RTV) sealants, deteriorate in service and should not be used for sealing between panels and sections of a contaminated exhaust housing. Lock seams, rivets, and bolts used in conventional construction for joining panels do not produce leaktight joints. When bolted flange joints are used between the housing and ducts, 1.5- by 1.5- by 0.25-in.-angle flanges with ASTM D1056 grade 2C5 or 30-40 Shore-A durometer neoprene gaskets are minimum requirements.¹⁴ A maximum bolt spacing of 4 in. is recommended for flanges.

Shop fabrication of housings is recommended over field fabrication because of the superior workmanship and control possible under shop conditions. These housings were built in sections and assembled in the field. Field joints for such housings should be seal-welded, since mastic and gasket-sealed joints cannot be considered reliable for permanent installations.

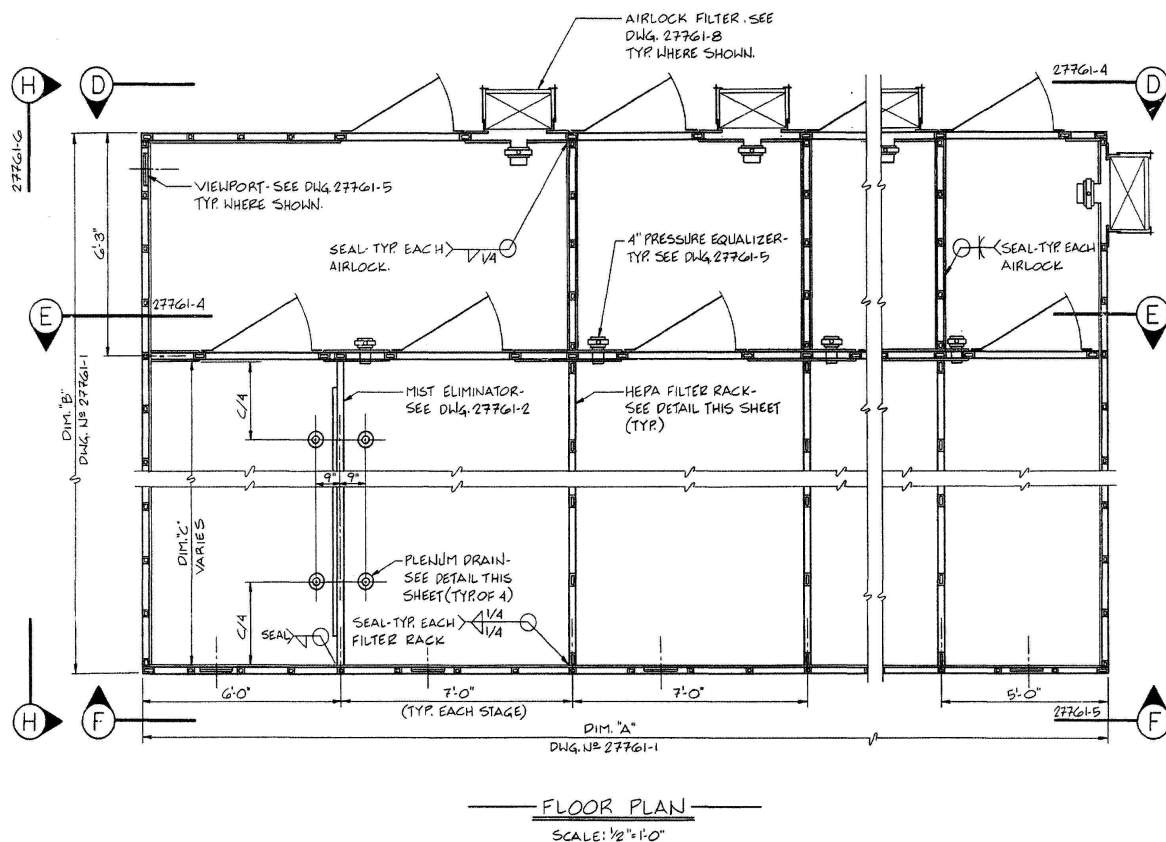


Figure 4.38

4.4.15 MASONRY AND CONCRETE HOUSINGS

Filter housings for low-gamma-activity systems and vaults for high- (or potentially high-) gamma-activity systems sometimes have been built as an integral part of the building structure. This construction is not recommended.

4.4.16 HOUSING FLOOR

Steel housings should have steel floors welded continuously to the walls of the housing. In no case should the housing be installed on a wood floor or on a floor having less than a 3-hr fire rating. A steel curb, welded to the floor, is recommended to raise the filter-mounting frame off the floor. The section of flooring between two banks of components must be considered a separate floor to be drained independently. Floors should be free of obstructions or raised items that would be hazardous to workmen.

4.4.17 HOUSING DOORS

Easily opened doors are essential on large housings, and more than one door is generally needed. A door should be provided to each compartment (space between banks) where maintenance, testing, or inspection may take place. The use of bolted-on removable panels

for access to filter compartments should be avoided for even the smallest filter housings when human entry is required. Sliding doors should never be used for filter housings, because they cannot be sealed and because they jam after any distortion of the housing.

Sturdy double-pin-hinged doors with rigid, close-fitting casings and positive latches, such as the marine bulkhead-type shown in **FIGURE 4.39**, should be provided on man-entry housings, particularly those for ESF and other high-hazard service. Doors and gaskets must be designed to maintain a hermetic seal under positive and negative pressures equal to at least the fan cut-off pressure. Doors of negative pressure systems must open outward and, since they may have to be opened against the negative pressure, a means for breaking the vacuum or for mechanically assisted opening is desirable. Doors should have heavy-duty hinges and positive latching devices that are operable from inside and outside. Means for locking, preferably a padlock, should be provided to prevent unauthorized entry. Door stiffness is important because flexible doors can be sprung when opened against negative pressure or allowed to slam shut under load. An air lock at the entry to the housing will eliminate problems with opening doors against negative pressure

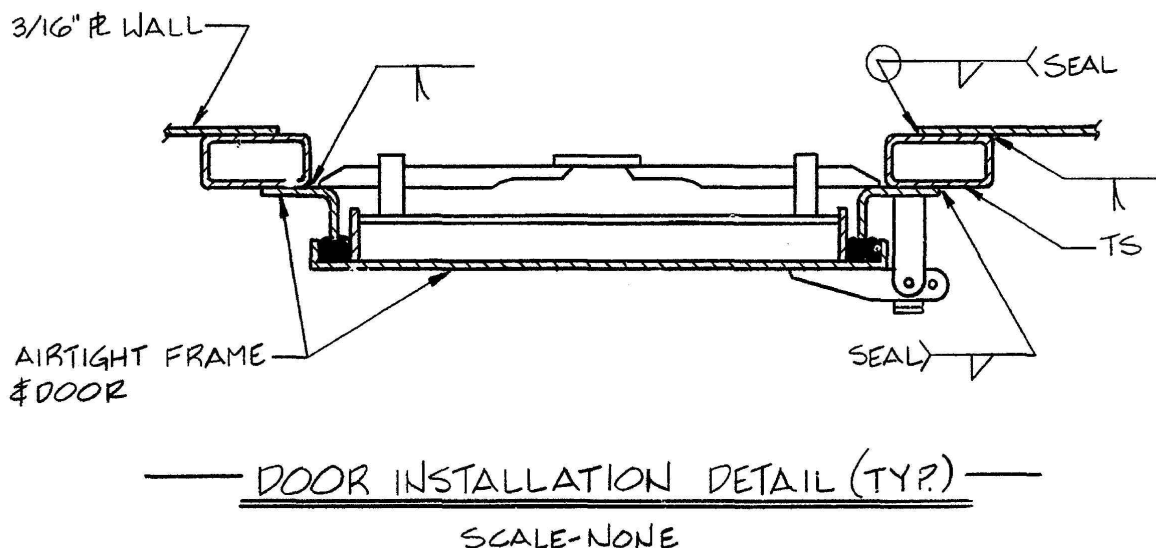


Figure 4.39 – Marine bulkhead-type door

and slamming, and, if large enough, will provide an intermediate work area for personnel during a filter change.

Housing doors of the type shown in **FIGURE 4.40** require a minimum of two latching dogs on each side. Lighter-construction doors require additional latches to achieve a satisfactory seal. Latching dogs should be operable from inside and outside the housing, and shafts must be fitted with O-rings, glands, or stuffing boxes to prevent leakage. Door hinges should be of the double-pin, loose-pin, or other type that will permit the full plane of the door to move perpendicular to the plane of the doorframe during the last fraction of an inch of closure. Single-pin hinges, which result in angular motion throughout the door closing arc, do not permit the door to seal properly and may cause the gasket to be rolled out of its groove after a period of use, thus resulting in the loss of



Figure 4.40 – Filter plenum entry door – no air lock type. Test manifold with valves shown

housing leaktightness. If door gaskets are too hard they will be incompressible, and the door cannot be sealed properly even with lever-and-wedge latching dogs. If too soft, the gasket will rapidly take a compression set and lose its ability to seal. Solid neoprene or silicone rubber of about 30-40 Shore-A durometer is recommended.

A compromise may have to be made in sizing doors for man-entry housings. On the one hand, the door must be large enough for easy access to personnel dressed in bulky protective clothing, wearing gas masks or respirators, and perhaps carrying 24- by 24- by 12-in. filters weighing up to 40 lb, or 26- by 6- by 30-in. adsorber cells weighing up to 130 lb (dimensions of the door through which a 95th-percentile man can pass erect carrying such loads are shown in **FIGURES 4.40 through 4.45**). On the other hand, the larger the door, the more difficult it is to seal and the more likely that it or its frame can be damaged if allowed to slam under load. The door should be as large as possible for easy access, but in no event should it be any less than 26 in. wide by 48 in. high. A coaming (2-in.-high minimum to 6-in.-high maximum) should be provided at all doors to prevent the outflow of contaminated water should the housing become flooded.



Figure 4.41 – Filter plenum – Inside locking at entry door



Figure 4.42 – Filter plenum – looking from outside through the air lock into the plenum



Figure 4.44 – Filter plenum door – wheel style



Figure 4.43 – Filter plenum – looking from outside into the air lock at the final stage upstream and downstream doors



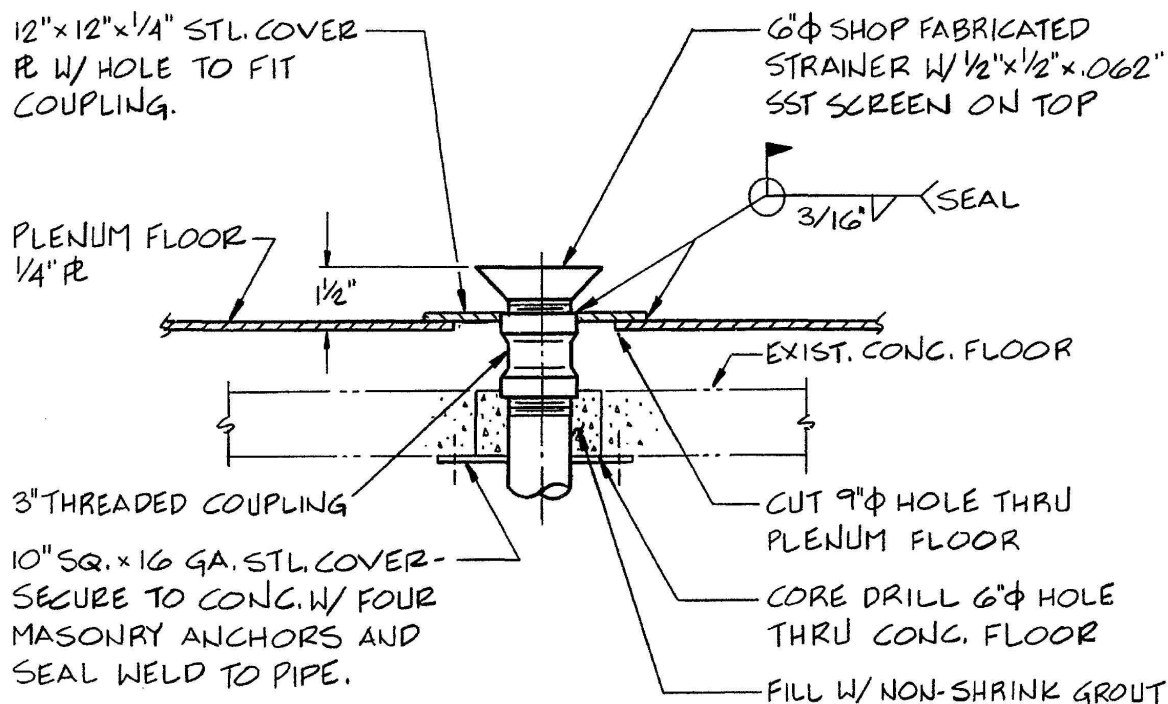
Figure 4.45 – Filter plenum door – bar style

4.4.18 HOUSING DRAINS

Floor drains are essential in contaminated-exhaust filter housings, particularly when sprinkler protection is provided. Even if moisture or condensation is not expected under normal conditions, occasional wash-down may be required for decontamination and water will be needed in the event of a fire. When the housing is above grade, the minimum provision for drainage is a Chicago half-coupling that is sealed with a bronze pipe plug using tetrafluorethylene (TFE) plastic "ribbon dope" so the plug can be easily removed when needed. When the filter is at or below grade, drains should be piped to an underground contaminated waste system during initial construction, since later drainage system installation is likely to be costly. Drains from ESF systems must also be piped to the radioactive waste system. In cold climates, water seats, traps, and drain lines must

be protected against freezing if they are above the frost line. When fire sprinklers are installed in the filter house, the drains must be sized to carry away the maximum sprinkler flow without water backup in the housing.

A separate drain is needed for each chamber of the filter house, and each drain must have its own water/loop seal or trap (**FIGURE 4.46**). The spaces between two banks of components in series are considered separate chambers. When piped to a common drain system, drain lines from the individual chambers of the housing must be valved, sealed, or otherwise protected to prevent bypassing of contaminated air around filters or adsorbers through the drain system. The drain system must be tested for leakage as part of the housing leak test, as well as part of system bypass testing of the HEPA and adsorbent filters.



PLENUM DRAIN DETAIL

SCALE: NONE

Figure 4.46

Provision must be made for those seals or traps to ensure they are filled with water during the plant life (**FIGURE 4.47**). A manual or automatic fill system may be utilized to ensure water seals do not evaporate for systems that do not experience moisture conditions continuously. **FIGURE 4.48** shows alternate methods of drain connection. The design of housing drain systems is often overlooked until the time of filter housing installation or testing when it is usually very difficult and expensive to resolve.

4.4.19 DEMISTER/MOISTURE SEPARATOR MOUNTING FRAME

The frame must be fabricated from corrosion-resistant, nonperforated steel sheet and must be formed and assembled in a manner that allows no bypassing of the separator pad (**FIGURES 4.49 through 4.53**). Drain holes must be provided in the bottom of the frame. The design must include provisions to assure the pad is maintained in its operating position and does not settle, pack down, or pull away from the top or sides of the frame when installed. Seals must be provided as necessary to prevent bypass of entrained liquid droplets.



Figure 4.47 – Filter plenum drain p-trap fill tube

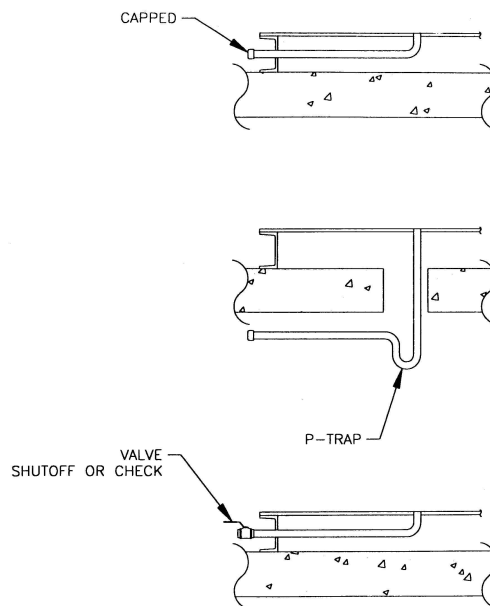


Figure 4.48 – Plenum drains



Figure 4.49 – Moisture separator/mounting frame



Figure 4.50 – Moisture separator mounting frame

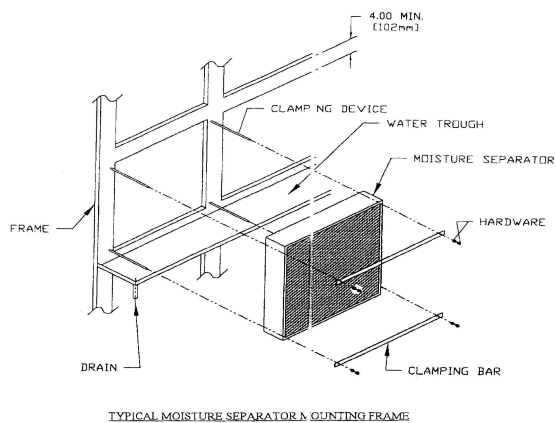


Figure 4.51 – Typical moisture separator mounting frame



Figure 4.52 – Moisture separator with heat sensor upstream side



Figure 4.53 – Moisture separator – downstream side